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THE DESIGN OF AND INTERACTION WITH E-TEXTBOOKS: A COLLECTIVE TEACHER ENGAGEMENT

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This article reports on an investigation of the design/re-design processes of a French grade 10 e-textbook (including its associated resources), which has been designed by the French Sésamath teacher association. These processes have been fostered by new 'digital' possibilities: platforms; discussion lists, etc. The object of the study has been the French Sésamath association, which mainly involved secondary school mathematics teachers designing various kinds of online teaching resources. The focus has been on their design of a Grade 10 e-textbook, more precisely the chapter on 'functions'. This design has been considered as a documentation work, and the analysis conducted with the theoretical perspective provided by Cultural-Historical Activity Theory. The authors studied the activity system of the e-textbook designer community, with particular focus on the resources, the rules and the division of labour in this system, their evolutions, and the factors of evolution. Three moments were identified, corresponding to three successive objects of the activity: a full-web e-textbook; interactive exercises; and finally a digital textbook. For lack of space, only one of these moments is presented, as an example. There is evidence that there were particular resources crucial for this collaborative work.

Keywords: E-textbook/s; mathematics teacher resources; textbook design; activity system; collaborative work.

INTRODUCTION

The traditional textbook has been recognized to play an important, perhaps crucial, role in teaching and learning (e.g. Pepin & Haggarty 2001). However, the e-textbook, as an emerging form of teaching material (including online materials and interactive functionalities), has been relatively sparsely investigated. One of the main issues is to determine, which specific features, different from the paper textbook, has an e-textbook.

In terms of teacher learning, textbooks are said to have a vital role to play. It has been found that textbook presentations are likely to influence teachers' beliefs and instructional practice (e.g. Nathan, Long, & Alibali 2002), and that they contributed to teachers' knowledge growth (Ma 1999). Ball & Cohen (1996) emphasize the textbook's role in supporting teacher learning and professional development, yet studies exploring the role of e-textbooks in supportive teacher learning environments have been scarce.

In this paper we report on an investigation of the design/re-design processes of a grade 10 e-textbook, which has been designed by the French teacher association Sésamath. It is hypothesized that the digital means challenge in particular the usual divide between experts as designers of resources and teachers as users: design and implementation/use are now intertwined, with teachers intervening in both (Gueudet & Trouche 2009).

The research question studied here is: what are the design processes attached to the Sésamath e-textbook, and in which ways do the roles of group members evolve over the development of the textbook?

ANALYTICAL FRAMEWORK AND METHODOLOGY

In terms of context, our aim was to analyse the emergence of e-textbooks as new types of teaching resource systems, designed by a different kind of "authors" (i.e. mathematics teachers, whereas traditionally textbooks are designed by teacher educators, or inspectors), and to investigate the development of new kinds of interactions between authors and users. We chose the Sésamath association, whose members were developing such new types of resources. Sésamath is a French association of in-service mathematics teachers (mainly from middle schools, around hundred teachers, with a board of nine members) created in 2001, whose main goal is to "freely distribute resources for mathematics teaching": online exercises (Mathenpoche – standing for "mathematics in the pocket", MeP in the following); textbooks; and various software. These are designed by groups of teachers collaboratively working to develop/produce a given set of resources. Each project involves about fifty teachers, and the different project groups gather several thousand teachers sharing the same collaborative platform, who are not formally members of Sésamath, but interested in developing shared resources through the engagement with Sésamath.

We will focus in this paper on the design of a Sésamath e-textbook, choosing a moment of change between two edition models: the first one was a single static book, available both online (under a pdf, but also an odt format, allowing teachers to make modifications) and in hard copy, accompanied by separated animations online (in particular MeP exercises); the second one was a flexible and dynamic digital textbook, i.e. an e-textbook, which a teacher could organize according to his/her needs, with animations and extra exercises integrated in each chapter. After having successively published 'static' textbooks for grade 7 (2006), grade 8 (2007), grade 9 (2008) and finally grade 6 (2009),, Sésamath decided to design an e-textbook for grade 10 (first grade of high/upper secondary school in France), according to the second model, and gathered a group, named here *e-textcom*, for this purpose. We decided to follow, from June 2009 to December 2013, the design of a particular chapter, dedicated to functions, because this theme assembled diverse representations (graphs, tables of values,

algebraic formulas) and offered possible links with the real world (in term of modelling), offering many opportunities for exchanging resources between e-textcom members.

Our investigations are anchored in the following data and their analyses: (1) for tracing the e-textcom activity, we have used its mailing list and the resources platform; (2) for tracing the interactions between the community and the members resources, we collected the designed resources shared by the members, during the realisation of the object; (3) for studying the interrelation between e-textcom and Sésamath board activity systems,, we used what we named a Small Agenda for Follow-up (SAF), filled in by two e-textcom members, chosen according to their role in the community (Benoît, Sésamath Board; Alexis, debates coordinator). Analysing these data, we identified different *moments* of the activity system transformation.

In terms of theoretical frameworks, we refer to Gueudet, Pepin, Sabra & Trouche (submitted) combining two frames: the documentational approach of didactics (Gueudet & Trouche 2009), in particular its meaning of resources, and the Cultural-Historical Activity Theory (CHAT) as defined by Engeström (2001).. Drawing on these we have analysed the evolution of the e-textcom activity system, focusing in particular on changes of the object of the activity (see Figure 1): we identified three successive objects of activity, each of them being associated to a particular *moment*. We show in the next section the activity system/s and its/their evolution during the first of these moments, and subsequently discuss the whole process.

THE FINDINGS: PRESENTATION OF ONEMOMENT IN THE EVOLUTION OF THE OBJECT

In June 2009, an initial group of 14 teachers, e-textcom, engaged in a Sésamath project, aiming to design a textbook "full Web" (flexible dynamic digital textbook) for grade 10. This project was the first Sésamath project for upper secondary school. During our observations from June 2009 to December 2013, we identified three moments. We present here in details the first moment, which took place between July 2009 and March 2010 corresponding to the object "designing a full web textbook for grade 10" (see figure 1).

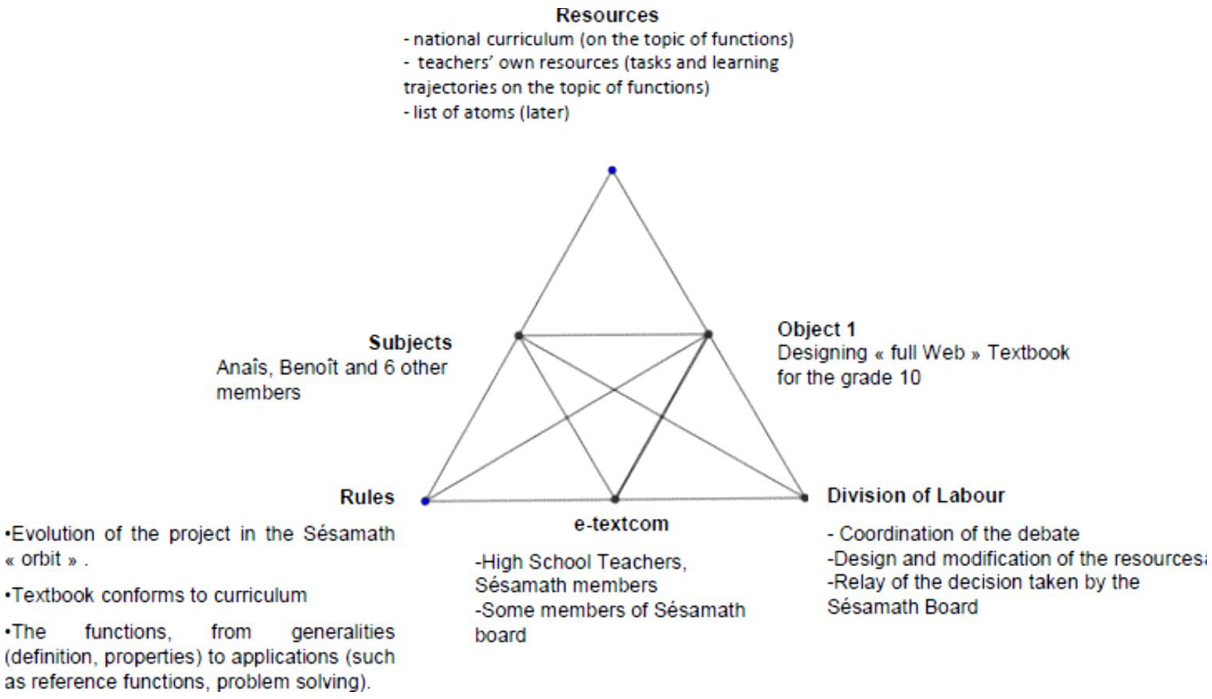

Figure 1. The "e-textcom" activity system at the first moment.

E-textcom gathered only high school mathematics teachers; some of them were also members of the Sésamath board. The project started with various kinds of resources: resources brought by members (in particular their own resources); resources provided by the association, in particular the collaborative platform, previous textbooks, MeP, a mailing list; and institutional resources, like in particular the grade 10 official curriculum. We observe that traditional (paper) textbooks do not seem to intervene as resources. The grade 10 official curriculum formed a central resource: it provided mediation between members at this early stage of the project. One important rule, 'inherited' from the middle school Sésamath projects, was to start with a list of elementary "tasks" identified from the official curriculum. This list played an essential role: each member chose to design exercises corresponding to a given task. A coordinator (see the roles below) checked if all the tasks were tackled by the e-textcom members.

For this textbook, a new vocabulary was introduced. A member of the Sésamath board proposed the term "atom", to describe the elementary units that would constitute the book. This term "atom" was then kept by e-textbook members; but they used it in fact as synonymous of "task". Thus, the first resource designed by the e-textcom members (drawing on the official curriculum, and on their own courses) was the list of "atoms".

The e-textcom members designed a new resource containing a list of 38 "atoms" for the chapter dedicated to functions in the grade 10 e-textbook Then e-textcom designed a "progression", i.e. a trajectory/order for the "atoms" to be taught/learnt. A "progression" is a very usual resource for teachers in France; each teacher, for a given class, has her/his "annual progression", the agenda of the contents to be taught during the year, sometimes designed with colleagues at the beginning of the school year. A "progression" can also be designed for a given theme; in the Sésamath middle school projects, for each theme the tasks were arranged according to a "progression". The multi-representational nature of functions

(graphic, algebraic, table of values) offered several possible entries and orders, and made the choice of a progression especially difficult. This progression was developed by members through discussions mediated by the resource "list of atoms", the curriculum and suggested progressions of some members, shared with the community.

This structure could also be viewed as providing rules for the community, and these rules reflected the ways functions should be introduced to students. In particular one rule was explicitly discussed on the mailing list: the functions theme should start with general statements, i.e. definition and properties, before developing more specific notions, i.e. "reference functions" (well-known examples) and applications.

The division of labour firstly drew on the division or labour retained in the middle school textbook project. Several roles were chosen, from the beginning; we identified them via the discussion on the mailing list and the associated resources: resource designers (each designer having to take into account the reviewers' propositions for resources which s/he designed); resource reviewers; a debate coordinator; a Sésamath 'torchbearer' aiming to keep the evolution of the project in the "orbit" of Sésamath projects.

The application of this division of labour followed a process organised in successive steps explicitly proposed by the coordinator:

1) design of a resource (exercise, or course) by a subject/member;

2) review of the resource by other subjects/members;

3) modification of the resource by the designer and proposal of a new version.

At each step, the coordinator had a crucial role. He managed the discrepancies coming from the reviewers, organizing the discussion between members (reviewers and designers).

During the nine months of this first moment, many exercises for the different atoms (exercises corresponding to the same "type of task") were written; and also a course corresponding to a part of the first chapter. Nevertheless, we observed structural tensions appearing in the activity system (tensions subjects – resources – object). E-textcom members were all teachers, and none were IT developers/specialists. But the design of a fully web-based textbook required technical skills, and the missing competence of an IT developer was an important obstacle.

In order to overcome these tensions, the e-textcom members contacted the Sésamath board: we observed here interactions between two activity systems, the Sésamath board and e-textcom activity systems. The contacts between the two systems led to the 'arrival' of IT developers as new members. They also led to change the object itself: since the present technical means and skills within e-textcom did not permit to reach the initial objective, the new object of the activity was the design of interactive resources for grade 10: this marked the beginning of the second moment

DISCUSSION AND CONCLUSIONS: COLLECTIVE DESIGN OF DIGITAL TEACHING RESOURCES- EVOLUTIONS IN A DYNAMIC ACTIVITY SYSTEM

In our analyses we identified three *moments* (exemplified by one in this paper) in the e-textbook activity system, corresponding to different objects of the activity. These evolutions, the changes in the object, were directly linked to the digital nature of the textbook to be designed: in line with the innovative nature of the resource, the members of the Sésamath board tried to develop new and more flexible learning paths, and new tasks that took advantage of the digital and flexible nature of the book, permitted by recent technological evolutions. Nevertheless, the initial project encountered technical obstacles, leading to a first change in the object, which evolved from a full-web textbook to interactive exercises. Conversely, unplanned technical means also brought evolutions.

From the evidence we present in this article (and other works on e-textbooks), it is clear that the collective design of an e-textbook is a complex matter. Our analysis proposes taking into account an evolving activity system (that of e-textcom), and its interactions with other activity systems (at least those of the Sésamath board, and of the middle school textbook developers), leading to the emergence of new roles and new rules. Specific roles were indeed required, not only authors and reviewers of resources (which exist for all textbooks) but also:

- a coordinator was crucial (also for an ordinary paper textbook) as soon as several authors intervened. S/he was especially needed in the case of e-textcom, because of:

  - the large number of non-expert authors involved in the design of the textbook;
  - the length of the design process (several years);
  - the change of the actors involved all along the duration of the project.

- a 'torchbearer' was important, since the Sésamath association provided the frame for the e-textbook project. The 'torchbearer' had to take charge of the coordination between the Sésamath board and e-textcom.

The rules appeared to evolve in line with the processes: the initial design was followed by a review step, then by a new design. However, this cycle could take several forms; it changed along the different moments. More generally, it seemed that e-textbooks, as shared resources designed by communities of teachers, evolving through interactions between individual and collective resource systems, constitute a promising field for new developments.

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